Texas Highways December, 1958 35c

Once again as we approach the Christmas season we should reflect on the wonders of this country in which we live and the blessings which have been granted to us. To all of you in the Highway family I extend the warmest of season's greetings.

The cooperation and teamwork of the employees of the Highway Department permit us to satisfactorily carry out our responsibility in developing the public road system of Texas. This is the foundation of our success.

I trust that in this time of world tension you will continue to be aware that you are contributing to the oldest of all geographical ties—the public road. As you perform your jobs each day you are helping to secure the bonds which tie our country together. You are building highways and roads over which our commerce is carried, our people travel and meet, and which serve our national defense. Yours is a job of increasing importance, requiring greater enthusiasm and imagination than ever before.

May this Christmas be the happiest you have ever known, and the coming year a time of satisfaction and fulfillment. I wish you a Merry Christmas.

D. C. GREER
State Highway Engineer

Texas Highways

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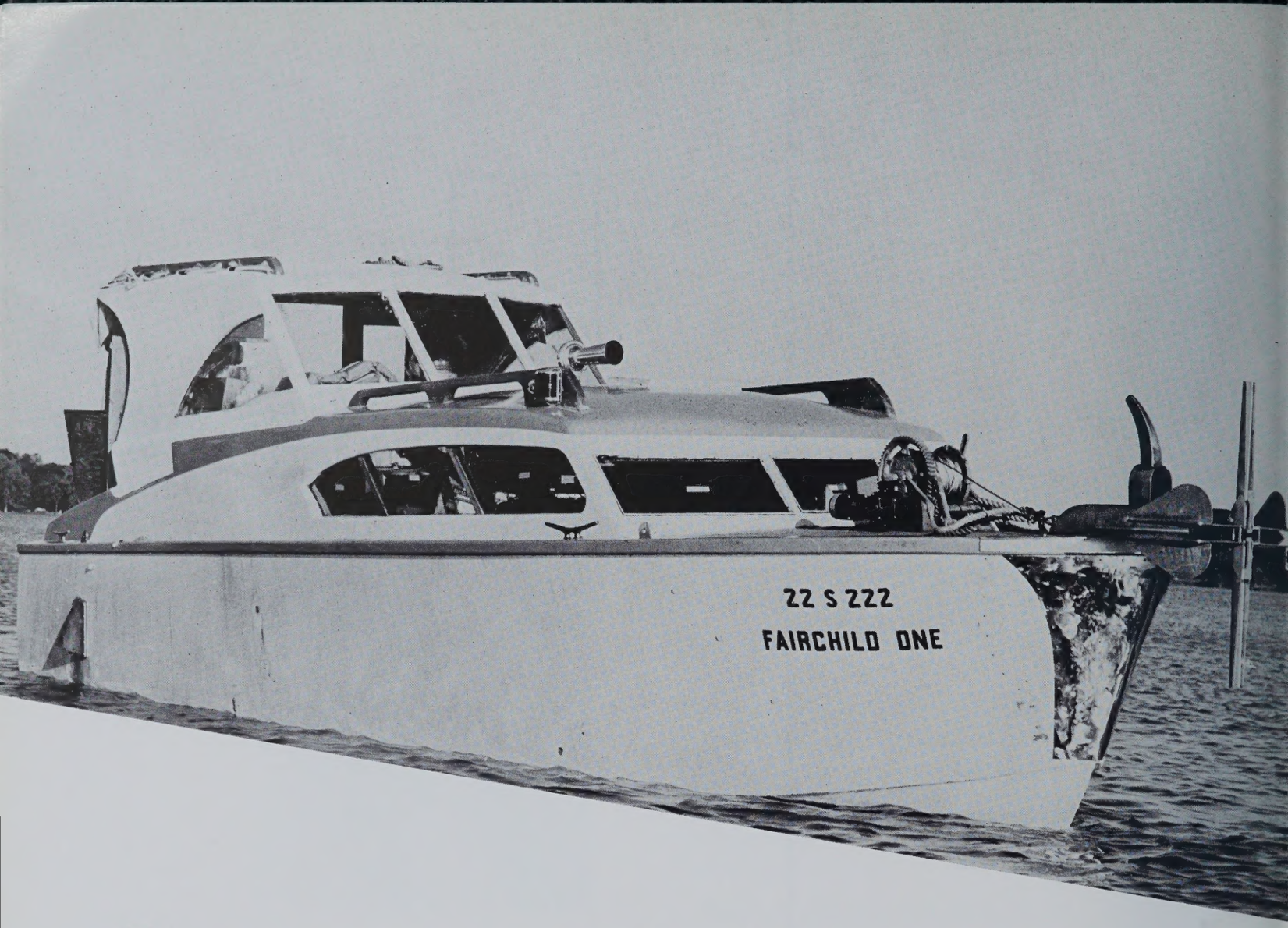


Lavaca Bay, at Port Lavaca, is crossed by State Highway 35. This open body of water is spanned by a timber substructure with concrete deck bridge 10,400 feet long. The west approach is about five feet above mean low tide, and of short length. The east approach is 5,130 feet long and currently at elevation 5.

Proposed is a concrete structure with the center line 350 feet north of the existing bridge, and about the same length. At this crossing the bay varies in depth, averaging about six feet. Underlying this is a muck of depths up to 30 feet.

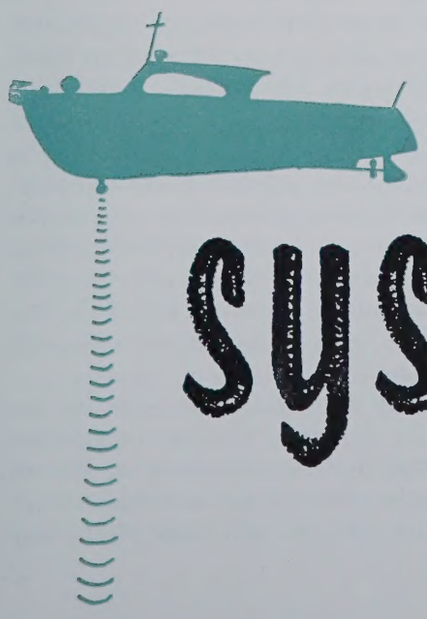
Since new approaches will be placed to elevation 10 above mean low tide, a great quantity of hydraulic fill material will be required to displace the muck before constructing the embankment fill. The great length of the east approach over this open body of water is continuously subjected to tidal action. Therefore a type of material that will withstand the carefree caresses of the tides requires very flat slopes, possibly 30 to 1 or flatter, for that portion of the fill above the bay floor. The bay in this area contains scattered available deposits of sand, shell, a mixture of sand and shell, and large areas of deep muck.

This means that to economically locate and evaluate suitable fill material areas for each approach is a huge undertaking. After thorough investigation, the matter was discussed with the Scientific Services Laboratories, Inc., of Dallas, Texas, who are affiliated with the Fairchild Aerial Surveys, Inc., of Los Angeles, California. This company agreed to make a Sonoprobe Survey of the area to be designated and prepare a map showing interpretative results. The cost for this work, on a day basis, was divided into two parts: (1) A Field Surveying Party to establish the triangulation grid system; and (2) A Sonoprobe Unit (consisting of boat, equipment, and survey party). This unit also prepared records, maps, and interpretation of results. Rate for Field Surveying Party was $135 per ten-hour day when needed, and for the Sonoprobe Unit was $660 per ten-hour day as used. Time required for the survey was nine days. Total amount for the service—$6,615.

There was little information at hand concerning the availability of acceptable and adequate hydraulic fill material, therefore a large area of the bay had to be covered with the Sonoprobe investigation so that no deposits would be overlooked which might be within economical pumping distance. Available information indicated the economical pumping distance would be around 4,000 feet, the feasible pumping range up to two miles, with about a three-mile distance as the maximum. Therefore,

« A part of the Sonoprobe Unit is the FAIRCHILD ONE.

A MARINE



sonoprobe system survey

W. A. King, Senior Resident Engineer
District 13

the entire width of the bay was covered about two miles to the south and two and a half miles to the north of the existing causeway. The entire area was laid out on 500-foot coordinates to make the Sonoprobe Survey. To have an accurate record, it was first necessary to make a map on this basis—numbering the east and west as well as the north and south coordinates. Following this, triangulation stations were established near the ends of the existing causeway, which was used as a base line in the system. Angles were computed from these triangulation stations for each coordinate intercept before any work on the survey was begun.

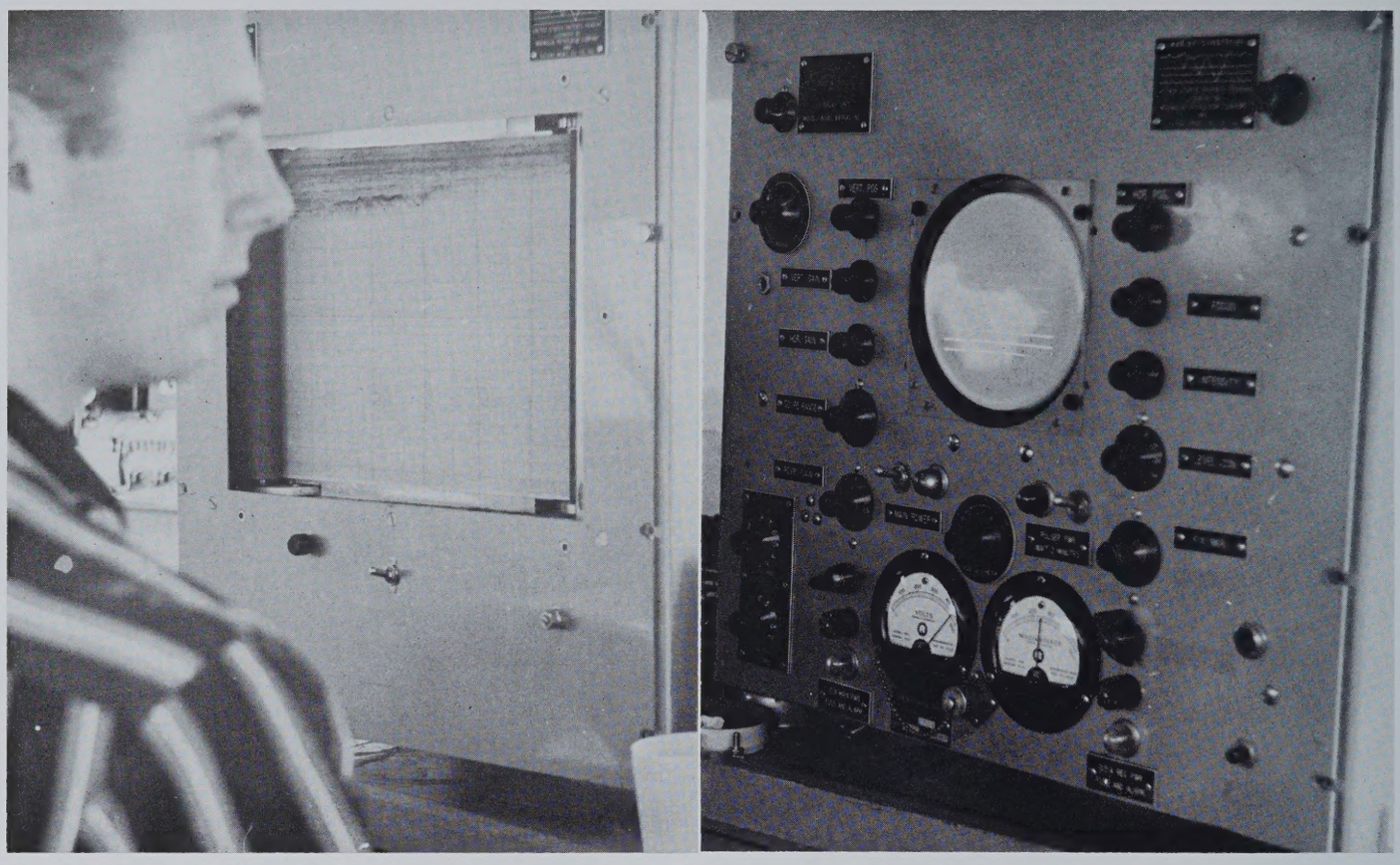
For controlling the continuous location of the Sonoprobe boat, an instrument man was stationed on a north-south coordinate line. Another was stationed on a triangulation station. Each man was equipped with radio communication, as was the Sonoprobe boat. With this equipment, each coordinate point could be marked as the boat passed over it. The instrument man remained on the triangulation station until all angles for that particular station had been used, while the instrument man on the north-south coordinate line was required to move to succeeding coordinate lines as the Sonoprobe Survey progressed.

Since a portion of these lines crossed the causeway, a portable platform attached to the sway bracing of the bridge was used. The instrument man on this platform controlled the course of the boat by transit and radio. His radio call was "Course Control." The instrument man on the triangulation station advised the boat by radio when each coordinate intercept was crossed, and his radio call was "Position Control." The Sonoprobe boat's radio call was "Fairchild One"; and when all three parties were in unison, a survey-line Sonoprobe picture was made. The Sonoprobe equipment made continuous pictures of the north-south coordinate lines only. This picture was electrically marked for coordinate intercept stations by the Sonoprobe operator as he was advised by "Position Control" that the boat was passing a coordinate point. In this way the picture reflected the true 500-foot distance between points, even though the boat speed could not be constant.

A picture was started near the causeway and progressed to the end of the line being run. To avoid loss of time, the procedure was reversed and a picture was made on the succeeding line in toward the causeway.

The Marine Sonoprobe, which is permanently mounted in the *Fairchild One,* consists of five separate units. There is a power unit which generates 60 cycles driving syncronous motors; a pulser unit which generated the electric power signal; a display unit to receive and control the circuits; a recording unit composed of an electric-spark paper recorder and timing synchronizers; and transducers composed of a magneto strictive concentric pulse generator transmitter and crystal receiver.

The motor in the recorder unit drives a synchronizer which fires to the display unit. There the signal is amplified and control circuits are

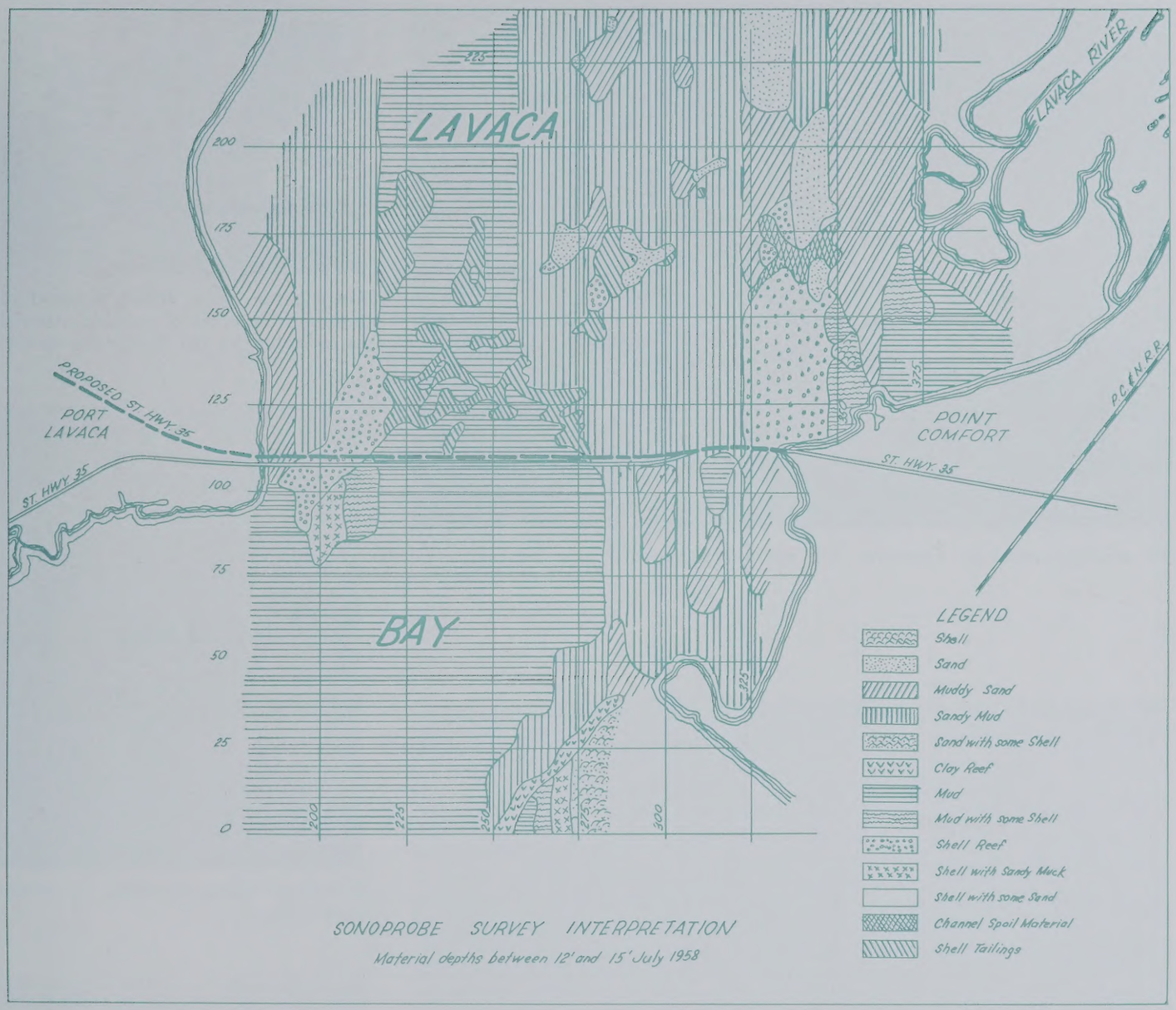


Aboard the FAIRCHILD ONE is the marine Sonoprobe display unit, with the recorder unit at left.

Neil Moore operates the Sonoprobe units.

triggered-in, causing a high-power pulse to be fired to the transmitter transducers. The crystal receives echoes which vary depending upon the acoustical impedance of the material and the barrier between material layers. This signal is compressed and amplified in the display unit and sent to the recorder to spark gap the paper. The paper is burned in varying degrees, corresponding to the impedance of the material encountered. A treated lead-backed paper is presently used, although this will possibly be changed to film in the future.

The Sonoprobe has been successfully used to determine the geologic trends for oil companies in offshore exploration and to locate bedrock for tidal dams in New England. To our



knowledge, this is the first attempt to locate and classify road-building materials. To check the Sonoprobe interpretation with known soil borings, a picture was made along the proposed center line of the new causeway where 33 borings had been drilled in 1957 to depths of around 100 feet. Both soundings and corings are needed to obtain maximum information with the Sonoprobe.

Sonoprobe interpretations for materials occurring to a depth of fifteen feet below the bay floor were then placed on a large-scale map, along with coordinate points. This map, with triangulation information, was part of the records furnished.

Progress of the survey was dependent upon weather conditions. About 24 miles of continuous picture could be made on a calm, clear day. Rough weather made it impossible to keep the boat on course, and at times high tides flooded the portable-instrument platform. Haze and cloudy weather also cut down survey visibility so that it was necessary to complete the extreme reaches of the survey in clear weather. An average of sixteen miles of line per day was completed throughout the field operation.

The Marine Sonoprobe was developed by Magnolia Petroleum Company and built by the Scientific Services Laboratories. On this survey the unit was operated by Neil Moore of Fairchild Aerial Surveys. Triangulation, computations, establishment of control points and maps were by John Gragg, Consulting Engineer, Dallas, Texas. Interpretation of pictures was by Neil Moore and W. H. Huckabay of the Scientific Services Laboratories, Inc.

Work was performed under the direction of the Victoria County Residency, supervised by W. A. King, Senior Resident Engineer, with J. M. Rylander, Resident Engineer, directly in charge of Field Operations.

The existing Lavaca Bay Causeway, with drawbridge up.

On a barge is the drilling rig used to drill holes in areas of suitable material as indicated by the Sonoprobe survey.

A towboat moves the drilling rig around Lavaca Bay.

The drilling rig is boring a possible material pit in Lavaca Bay.

The Highway Department drilling crew poses with the rig.

Upon completion of these field investigations we decided that further study should be made to verify the interpretative results given by the Sonoprobe Survey. A complete barge-mounted boring rig was assembled to drill holes on each coordinate intercept in exactly the position laid out by triangulation, but only in areas where suitable material was designated on the Sonoprobe map.

Borings were drilled into firm clay, regardless of depth. Samples were taken of each change of material. Soil constants were later determined for each sample taken, to and including the clay, although the Sonoprobe picture was only read for type of material occurring to a depth of fifteen feet below the bay floor. By this, additional suitable material was found at lower depths which can be used if needed.

Results of these borings and laboratory tests of material strata encountered were completed in the Residency, and data was plotted on the map with Sonoprobe interpretations.

From these studies, a vast amount of suitable material was located within economical pumping distance for construction of the proposed hydraulic fill on both sides of Lavaca Bay.

First Christmas in Texas

"Here, on the top of a hill, I had a holy cross planted." A simple notation, written by a Spanish commander in his journal of the day's happenings, locates the first Texas observance of Christ's birth near what is now the city of Presidio.

The brief and starkly pious ceremony mentioned by Juan Dominguez de Mendoza, leader of a detachment of soldiers "going to the discovery of the East and the kingdom of Texas" is considered the oldest Christmas relic in recorded history's collection of Texas Christmases. That was the year 1683.

Other antique December twenty-fifths scattered north, south, east, and west through the state's centuries have been found by those who have sifted and searched. When held to view, some of these observances give a glimpse of Texans who could barely pause from their grim pursuit of survival to nod at the date. Other incidents reveal humans who pleasured themselves and made rollicking fun despite the lack of the trappings of civilization.

A look at Christmas in early Texas would start there in western Texas 275 years ago with the cross set by de Mendoza's soldiers at the beginning of a trek which took them into the state as far as present-day San Angelo.

Three years later, members of La Salle's colony were singing midnight mass on Garcitas Creek, located in what is now Victoria County. Like a Christmas ornament in history's attic trunk, the words of Joutel's *Journal of La Salle's Last Journey* read:

"Monsier de la Sale being recover'd from his Indisposition, preparations were again made for his Journey; but we first kept the Christmas Holy-Days. The Midnight Mass was sung, and on Twelve-Day, we cry'd The King drinks (according to the custom of France) tho' we had only Water."

The buccaneers on Galveston Island crashed into seasonal celebration with the same fervor they practiced their questionable profession. An article in the *Galveston Daily News* in 1920 and authored by Dr. J. O. Dyer pulls out of the storage bin of time a flashback of Christmas in the harbor of pirates.

"Without rum there would have been no holiday season in the old buccaneer days, for on celebra-

tion days the daily ration was trebled. . . .

"Methods of preparing the holiday punch have not mutated greatly. The rum was stronger, the hot water more muddled, and the sugar was damp, brown and molasses-flavored; and in the buccaneer camps they got both spices and limes from Jamaica, and when the condiments were lacking a little red pepper took the place and added "kick" to the taste. . . .

"The playing of tricks and pranks was common enough in the old pioneer days, but on New Year's Day the camp of Lafitte resounded with the hoarse laughs and shouts that accompany 'horseplay' among the vulgar and ignorant. . . ."

Considerably more homespun is the account of Christmas dinner eaten by immigrant families headed for Stephen F. Austin's headquarters for a land grant in 1828. This, too, happened along the Gulf Coast. D. W. C. Baker says in *A Texas Scrapbook,*

> "A gentle breeze and fair wind sprang up, and soon we were off the mouth of the Colorado, and within about two miles of Matagorda, which then contained two families, who had lately moved down and commenced a settlement. The next day Mr. Wightman and another went to the settlement, and returned with the present of a Christmas dinner, which consisted of some hominy, beat in a wooden mortar, and . . . fresh milk, which were gratefully received and promptly dispatched."

Nine years later, in 1837, Mrs. Mary Austin Holley spent Christmas Day in Houston and wrote this:

> "All was business & bustle. The army disbanded—the militia to organize. Meetings were called, money —$2000 to $3000—subscribed, & men enrolled (600 in one day) all was excitement. From Mrs. Allens gallery we could overlook the whole town in motion like bees swarming —cluster of men in confab—a rushing to the Presidents house next door—every body in movement. Nobody was afraid, but everybody was busy. . . . Egg-nog not plenty at Christmas — eggs worth 50 cts each $6 per doz in Houston Heard of one doz: sold for $13 . . . candles 50 cts each. Sugar—none."

At the frontier capital of Austin in 1841 "All distinguished rounders of the republic" were invited to attend a Christmas Ball "at the grand hall above the Bexar Exchange." Congress of the Republic was in session. In levity it was decided "that no member should be required to speak with any relevancy to the subject under consideration. . . . The Congress was liberally supplied with plenty of the source of hilarious vitality, and never . . . has a more intelligent, witty, or business-like body convened in the world," said *The Daily Bulletin.*

Two days before Christmas, 1860, Robert E. Lee arrived at Fort Mason in a freezing rain. He spent Christmas Day there. Within 60 days Texas had seceded from the Union. The next year on Christmas Day Texas was a Confederate State, and on that day the military organization of Texas was completed.

Two souvenir Christmases have been left on record for the historian by early engineers. Limestone County surveyors, who were forced to spend the big day camping out, named the creek nearby, "Christmas Creek." In 1872 a West Texas party of surveyors, Captain Jack Elgin writes in his recollections, ate foods such as "No prince, potentate, or magnate ever sat down to. . . . I think we had fourteen varieties of meat. We could have had sixteen, as one of our hunters offered to furnish us with a mess of rattlesnakes and polecats, which he assured us were a most excellent delicacy, but our cook drew the line at these. The variety in which the meat was cooked was almost as great as the variety of the meat. We had buffalo, antelope, deer, bear, rabbit, prairie-dog, possum, and possibly other animals that I do not recall; turkey, goose, brant, ducks, prairie-chicken, curlew, quail, and other birds. The most expensive meat which we had upon the table was bacon, which we had had to haul five hundred miles. Of course I had a small supply of bacon to use in a contingency, and we took a little of it to fill up the menu. . . ."

These recollections of Christmases past are but a token handful of all that have been recorded in early Texas history. From first to last, each of those recounted here has given a picture of humans on the move.

Texas was only one stretch of uncharted land in every direction to the Spanish explorers dismounting their horses to set a cross at Presidio, Christmas, 1683. But down the parade of 275 Christmases since, much of the geographical unknown has been turned into certainty. What contrast to the situation of the Spaniards is the fact that a Presidio family today piling into the station wagon on Christmas Eve in the morning can blithely follow where civilization leads, down a highway to the glittering tree, the feast, and Santa Claus at grandmother's house, eight hours and four hundred miles away!

Making a Welded

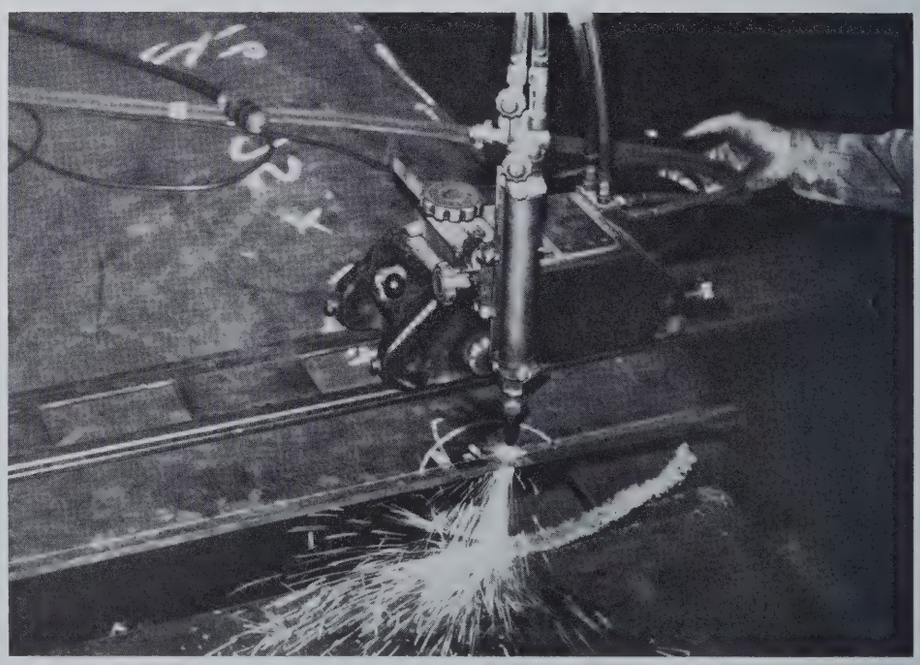
"The old order changeth, yielding place to new." Whether said by King Arthur or a bridge engineer, times do change and with them, the means we use to achieve our ends.

For many years prior to 1948, the Texas Highway Department was a devoted user of riveted steel bridge girders. The last few years, however, have seen the increased use of a new method of girder construction—metal-arc welding of steel plate. Long a pioneer in new techniques of highway and bridge construction, the Department has converted almost entirely to this new and improved type of girder fabrication.

Department engineers are utilizing welded steel because it combines strength equal to that of riveted members, with lighter weight. Use of welded steel reduces the weight of structural steel in a bridge by about 20 per cent. Lower production costs, lower bid prices, and a more beautiful finished structure result from welded steel. Its use is primarily in highway bridge construction. Increased use on railroad bridges is expected in the future.

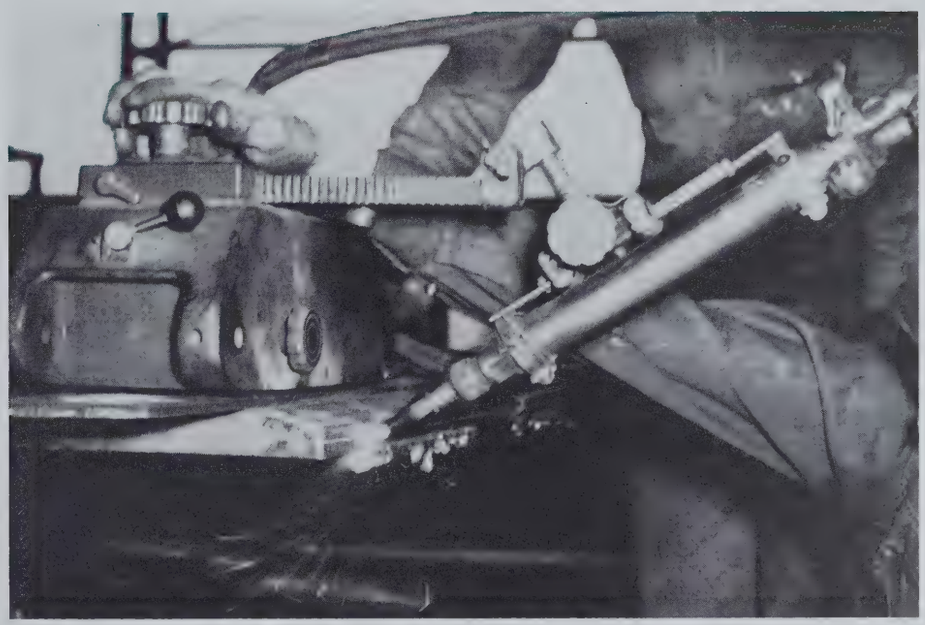
Girder fabricators in the Southwest are highly in favor of welded steel construction. When asked the reasons why, one fabricator replied that welded steel does not require the capital outlay of a riveted assembly shop. Less manpower is necessary, therefore overhead and production costs are lower than comparable riveted construction.

TEXAS HIGHWAYS made a trip through one welded steel fabrication shop and here shows you the various steps involved in the process.

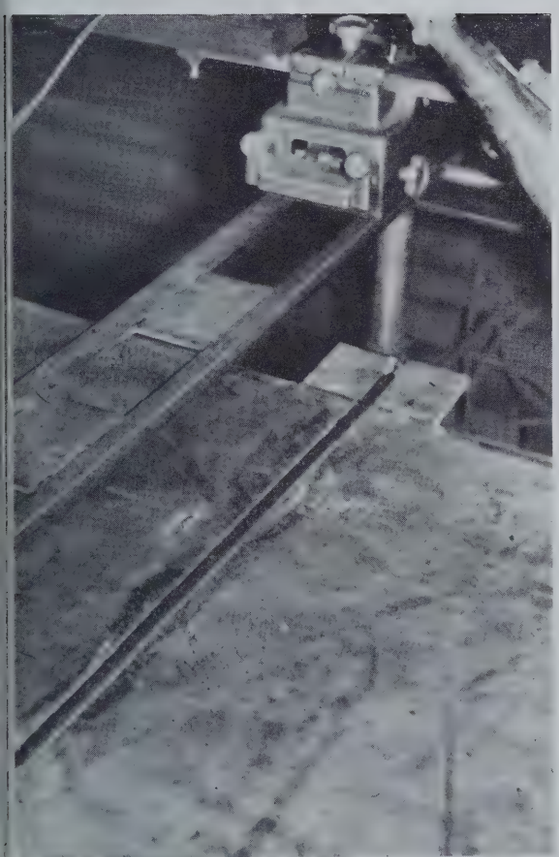


When the web plate arrives from the mill, its edges are trimmed in preparation for splicing the web to the flange. The ends of the plate will be trimmed to fit the adjacent girder sections. The acetylene torch used in this step is mounted on a track-guided, constant-speed tractor.

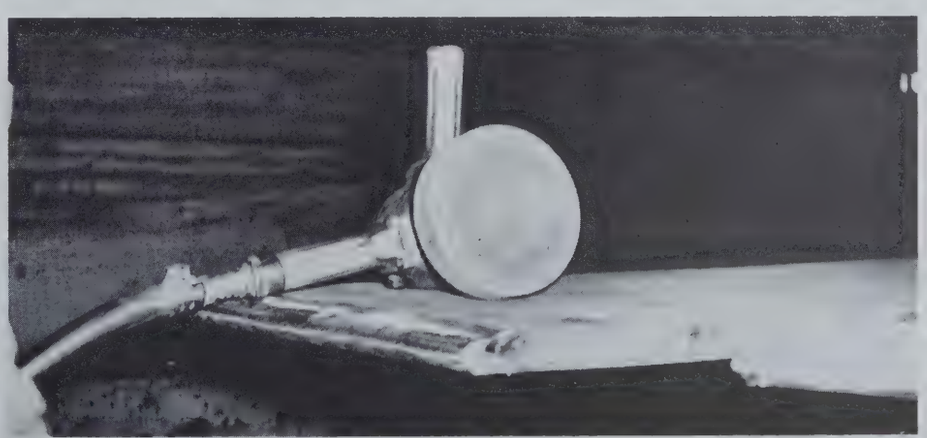
Steel Plate Girder



An acetylene torch and tractor make a cut on a flange plate. The plate is beveled in preparation for a butt-welded flange splice.

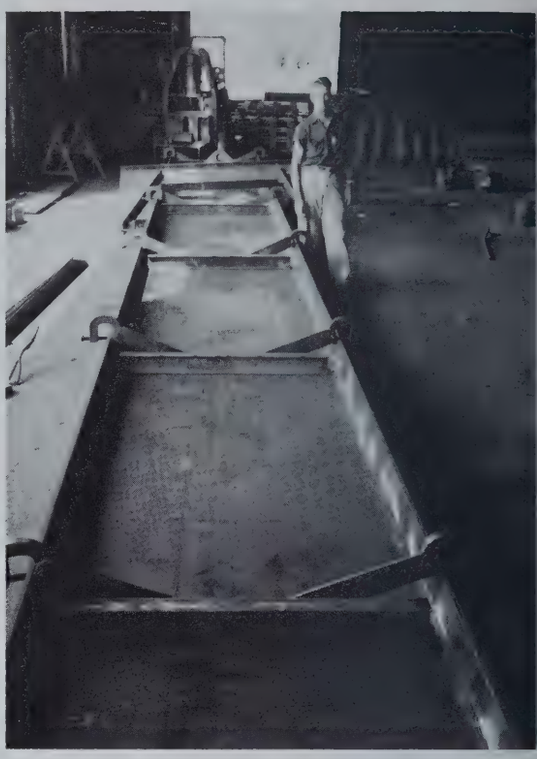


The completed web splice is made with submerged-arc welding equipment. Extension bars on the edge of the plate permit a sound weld at edges of plate. The weld is continued past the edge, producing a good quality weld to the edge after extension bars are removed.



After the torch makes the initial cut, this air-motor grinder completes preparation for the splice. The flange is ground down until its end thickness matches the thickness of the adjacent girder.

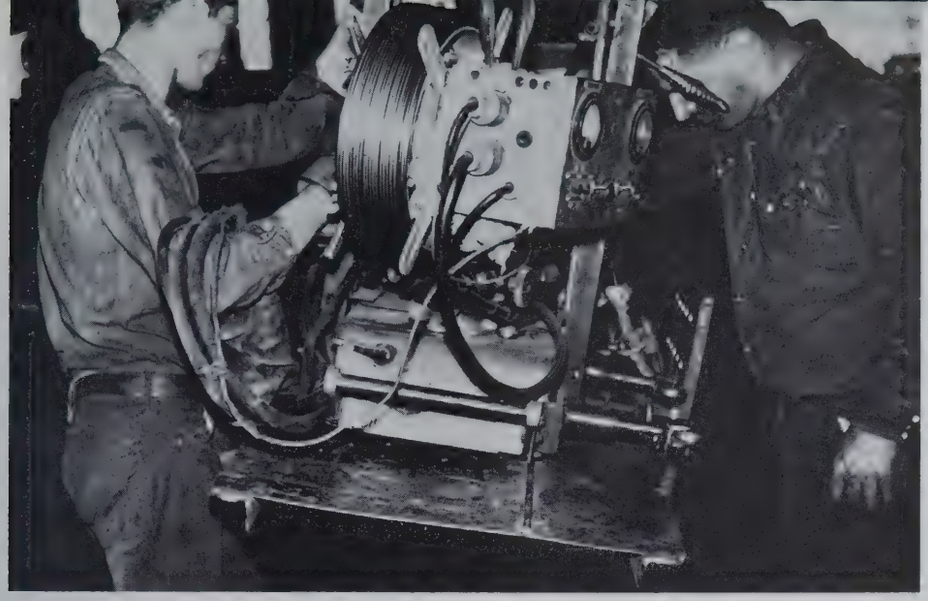
The butt-flange splice is welded with submerged-arc equipment. This welding rig is a squirt-gun type mounted on a constant-speed tractor.



C-clamps are inserted to keep flanges perpendicular to the web plate during welding of the flange-to-web fillet. The girder is turned over and welds placed on the opposite side of this girder. Clamps are then removed and welding completed on this side.

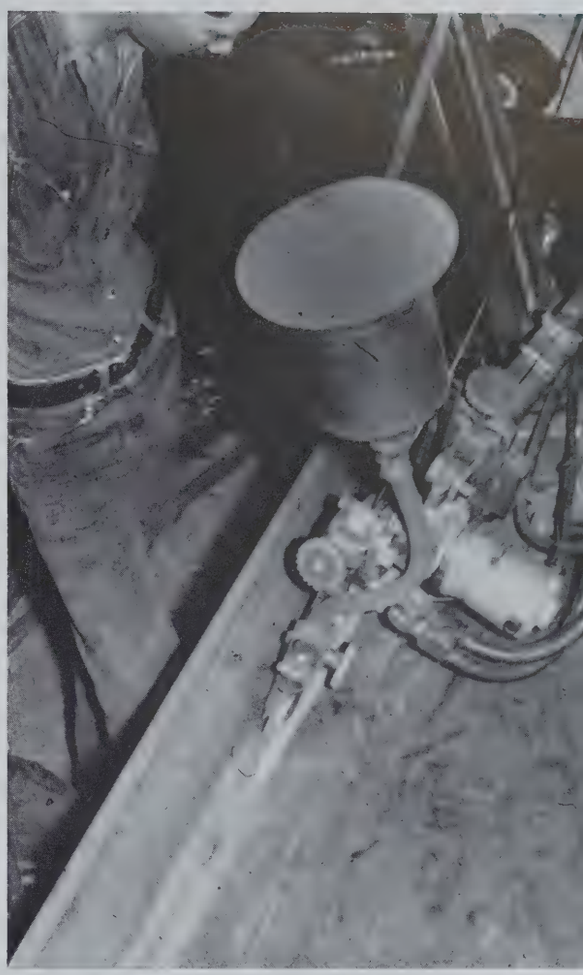
« The butt-flange splice is completed. Note extension bars at each end. This splice illustrates the change in thickness of the flange plates. The thicker flange plate is trimmed back on a slope of four to one.

« Girder assembly follows web splicing and flange splicing. Jacks on this rig, which ride along the flange plates themselves, tightly press flange plates against the web. Flanges are held absolutely perpendicular to the web and tack welded in that position. Tack welding can be seen on the inside of the flange plate between flange and web. Note temporary stiffeners tacked to the web for increased stability during flange-to-web welding.



This rear view of the rig shows the welding electrode in coils, also voltage and amperage indicators. Extensions on the end of the girder allow welding to start as near the end of the girder as possible.

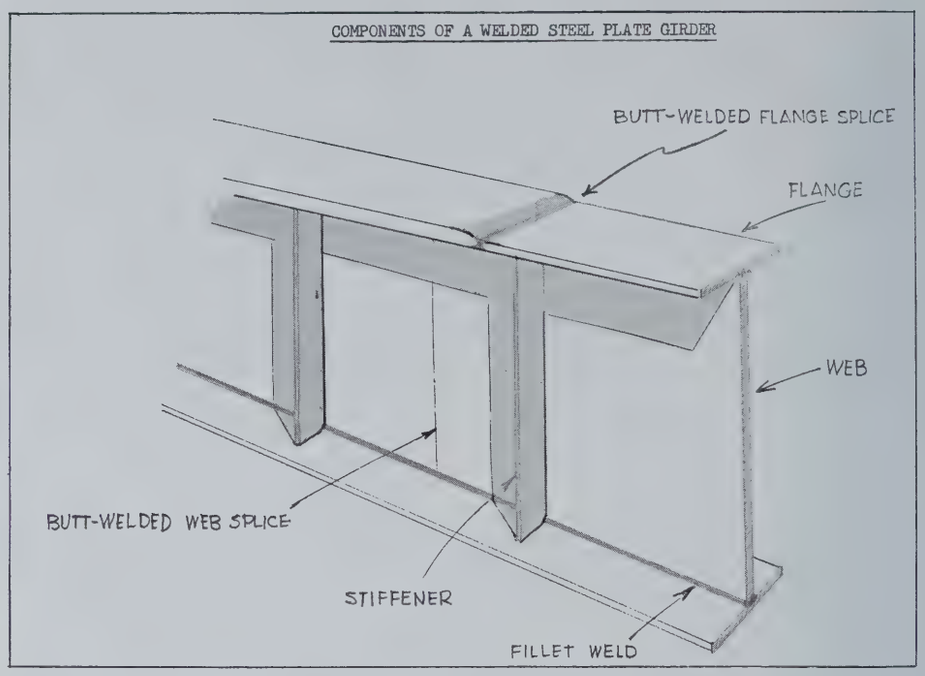
After assembly and fillet welds are completed, the girder is stripped of all C-clamps and temporary stiffeners. Web splice is visible in the foreground. The girder is cleaned and laid flat prior to inserting intermediate stiffeners.



With C-clamps still attached underneath, the fillet is made in flat position. The automatic submerged-arc rig is guided by a concave wheel which will ride over tack welds placed in its path.

Flanges must be slightly bent outward to allow insertion of stiffeners, accomplished by the jack in the foreground. After stiffeners, precisely machined to exact dimension, are inserted, the jack « is released. Flanges spring tightly back into place. Stiffeners are intermittently stitch-welded to the web plate, then continuously welded completely around on the compression flange with no weld on the tension flange.

Stiffener is completely inserted, with stitch welds being applied.



This view of the Sixty-ninth Street Bridge in Houston, with stiffeners plainly visible, illustrates the use of welded steel girders.

Department Accountants Meet

Balancing the books of 25 or more little highway departments was the main subject up for discussion when Texas Highway Department accountants from all over the state got together in Austin on October 23 and 24. It's quite a feat keeping tab on the millions of dollars that pass through the Department. And its accompanying problems are unending.

Conducted by Accounting Director George Pendergrass and Harry Johnson, Assistant Director of Accounting, the group laid most all their problems on the table, reaching conclusions which will help keep track of everything from nine-figure numbers on down to four-cent postage stamps. The new retirement law, which became effective September 1, 1958, was discussed in the light of changes it will make in accounting procedures. Annual warehouse stock inventories, right of way accounting, material purchasing, and personnel problems also received their share of time on the agenda.

Those attending were George A. Henderson and Billy Joe Kennedy, District 1; Lee S. Reese Jr. and William B. Pollard, District 2; Raymond L. Medford and Allen O. Blodgett, District 3; Archie K. Dixon, Lee Hagen, and Horace Ammons, District 4; Harold Dunn, Arthur N. Hanners, and Billy Warren, District 5.

Also H. E. McLauren, Marvin Gillespie, and William A. Fox, District 6; Henry B. Briley, District 7; John D. Richardson and Clifford D. Park, District 8; Elmer C. Kunz Jr. and Joel E. Williams, District 9; Max E. Byrd, District 10; Paul Clark and Charles T. Currie, District 11; Charles E. Tipton and Jackson Chancy, District 12.

Others were John D. Vogt and Vernon Bruns, District 13; Marvin Adams, Oscar Thoresen, and Alvin C. Cloer, District 14; Daniel W. Burks and Amos Hilburn, District 15; Fred Khoury and Albert Puckett, District 16; William C. Vaughn and Russell Wade, District 17; Sterling Davis and Hudson Jones, District 18.

Also William Dickinson and June Gunter, District 19; D. L. Morton Jr. and John DeLacie, District 20; Van W. Wheat and Lawrence Wilks, District 21; Lauris A. Weathers and Kenneth D. Bond, District 22; William T. Moore and Robert Cannon, District 23.

Also J. T. Peterson and Earl Welch Jr., District 24; Obert Stevens, Henry M. Baker Jr., and Chester Hudlow, District 25; William Wilson and John Nygard, Houston Expressway Office; Jimmy McGuire, Paul Hancock, Norman Wilson, and Robert Flaherty, Camp Hubbard.

From D-11 were Billy Hines, Abie Cohn, Ray Boies, Bill Key, Glynn Drake, Jay Howell, and Melvin Green, Field Auditors; Harry Johnson, Assistant Director of Accounting; and George Pendergrass, Director of Accounting.

Irrigation Does The Trick

Take several thousand acres of bone-dry sand, try to make a highway, and you'll have a slide rule full of problems. Ever since some ancient Eastern engineer first put his hand to building a desert road for his king's chariots, shifting sands have been a thorn in the construction man's side.

In the sand hills east of El Paso, on the construction of a section of four-lane divided Interstate 10, engineers have had their share of shifting sand and its associated headaches. Their difficulty lay in working the sand into a usable condition and having it remain so. The reduction of sand drifts in the area added even more problems.

Irrigation was the solution. An elaborate piping system was devised to transport water to the construction site from wells specially dug for the project. These wells are usually one to one and one-half miles distant. They range in depth from 800 to 1,200 feet, delivering 500 to 1,200 gallons per minute.

At both the roadway excavation areas and borrow pits, an aluminum pipe system with heavy-duty sprinkler heads was laid out in a grid system covering an entire borrow pit or grade cut. Booster pumps halfway between the wells and job site allow approximately 150 pounds of working pressure at sprinkler heads.

In its original dry state, sand in the area tends to drift—allowing no stability for working. It is difficult to manipulate both from the construction standpoint and in lasting quality of pavement base once construction is completed. With proper irrigation, however, the sand becomes dense enough to be moved, hauled, shaped, or put through any of the various requirements of highway construction. After construction is completed, the pavement surface acts as a seal causing the sand to retain much of its moisture, thereby providing a more stable roadway base.

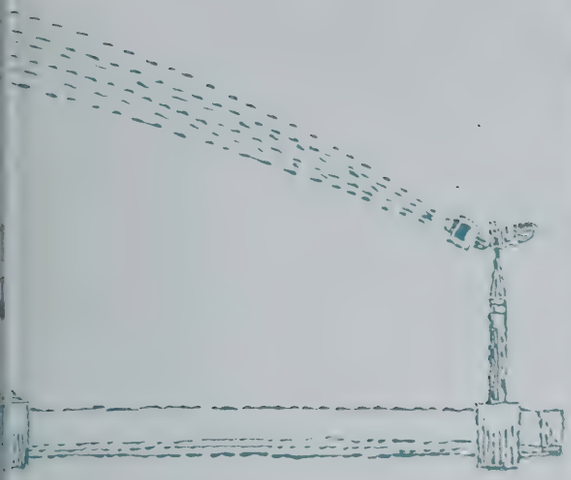
In both excavated areas and borrow pits, irrigation is regulated to penetrate about one foot below the cut section. Some 40 to 50 gallons per cubic yard, with a penetration of two feet each 24 hours, is usually required. The first three feet in depth of irrigation move slowly, but after a head of moisture is built up it begins to drop more rapidly. Average cut sections require three or four days for adequate irrigation, while borrow pits of 100,000 cubic yards require seven days. Borrow pits of this size use several million gallons.

If water were carried in a conventional tank truck, the average load would cost between $1 and $1.50 per 1,000 gallons. This cost does not include wear on the truck in getting through the sand nor their occasional complete disability without the aid of heavy machinery to pull them through. With the system of wells and piping, cost of transporting water through sand dunes has been greatly reduced.

On the Interstate 10 job water is also being used in drilling pilot holes for precast concrete piling. Engineers are using a rotary drill with water jets to accomplish several operations —material is washed out of the hole, the bit is cooled, and the earth stabilized to prevent cave-ins.

Before this irrigation process was used, surveying of the job was seriously hampered. Some hubs were completely covered by drifts and others were moved several feet from their original locations. It was necessary to resurvey some places only a few hours ahead of construction because of the rapid change of contour.

Pipes snake out across the desert area, transporting the water which makes a workable material of the shifting sand.



Sprinkler heads place the water over the work area.

The wet sand is easily worked, and equipment can be moved in without fear that it will bog down.

A. C. Gentry Retires

On October 31 of this year, the Highway Department lost one of its pioneer employees. Former District Engineer A. C. Gentry of Tyler, retired after eighteen years as head of District 10, and almost 37 years with the Department.

Groups all over East Texas have been honoring Gentry during the past months with dinners, testimonials, plaques, and gifts. At a luncheon held by Henderson and Rusk County, Commission Chairman Marshall Formby had this to say about Gentry, "His public relations have been excellent and he has been one of the key people in making the Texas Highway Department one of the best in the nation."

Known over East Texas as Mr. Highway, Gentry was named "Engineer of the Year" in 1955 by the East Texas Chapter of the Texas Society of Professional Engineers.

Born in Smith county in 1893, Gentry is a quiet, reserved-appearing man with the keen blue eyes of the engineer of vision. He graduated from the University of Texas in 1918 in architectural engineering, and began work with the Department in 1919 as Assistant Engineer in Smith County.

Since Gentry became District Engineer in District 1 in 1941, the highway system mileage there has more than doubled.

W.W. Potter New D.E.

Replacing Gentry as District Engineer for District 10, headquartered in Tyler, is W. W. Potter, formerly of Fort Worth.

Born in Weatherford, Potter is a 1939 graduate of Texas A & M College in civil engineering. He went to work for the Department in 1939 as a rodman at Wichita Falls, and for the last eight years has been Assistant District Engineer of District 2.

Potter, 42, served in the U. S. Army during World War II for four years, and was discharged as a major.

Computer Section

solves earthwork problems

Flashing lights, punched cards, and a labyrinth of wires and buttons are continuing to take a great load off the field engineer's mind. With lightning speed the Computer Section at the Main Office in Austin is producing calculations and solving complex mathematics in a fraction of the time required by human mental processes.

The December, 1957, issue of TEXAS HIGHWAYS summarized the work of the Computer Section after only one year of operation. At that time, the Electronic Digital Computer was performing such jobs as solving traverse survey problems, computing bridge design problems and triaxial test data, extending bids for letting, and computing earthwork quantities.

During 1958, the computer has not only saved countless man-hours in each of these functions, but use of the machine for solving earthwork quantities has proved of inestimable value. The Computer Section's earthwork program, accentuated by the Department, still has great potentiality for saving the engineer's time on earthwork computations. After he submits preliminary data on special cards designed for operation with the computer, automation takes over. The engineer is left to deal with problems and decisions requiring human judgment and evaluation.

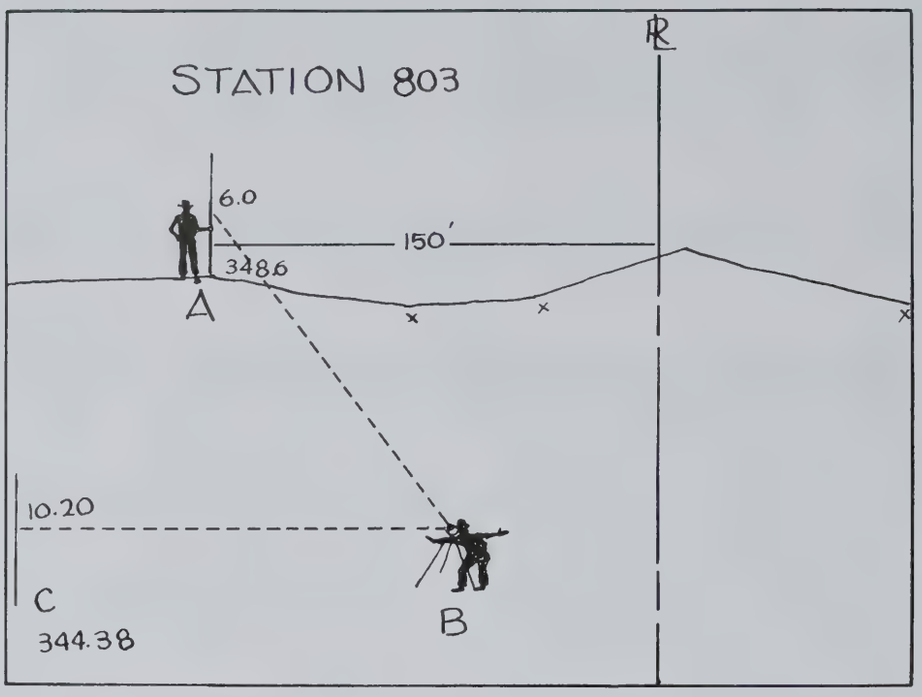
In this article, TEXAS HIGHWAYS moves, step by step, through the procedure used for solving earthwork quantities with the electronic computer. A hypothetical problem is set up, with each listing and computation based on that problem.

The illustrated example uses the mark-sense card method of taking notes in the field, allowing data to be transferred to punched cards automatically by machine. Conventional procedure of taking notes in a field notebook may be used, but the notes must be transferred to cross-section data forms. The Computer Section later hand punches cards to correspond with data on the forms. This process is much slower and more costly, and involves two verifying operations not needed in the mark-sense card method.

Processes used by the Computer Section are under constant alteration and improvement as short cuts are discovered and present methods improved. The steps outlined here are simplified and more flexible than those of a year ago.

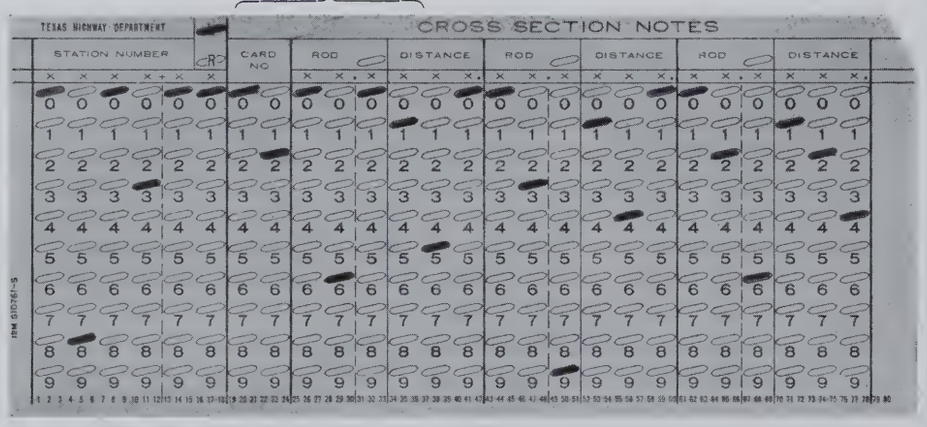
For initially determining elevations of the various points of a cross section, there are two types of rods. One, the Philadelphia rod, has the scale arranged with zero at the bottom, increasing to thirteen at the top.

The second type, called the automatic or direct reading rod, has a tape which can be set at the height of instrument (H.I.) when the rod is placed on a point of known elevation. Elevation of other points are read directly from the rod with the same instrument setup. Data from either rod can be machine processed. In Illustration 1, the Philadelphia rod is used.

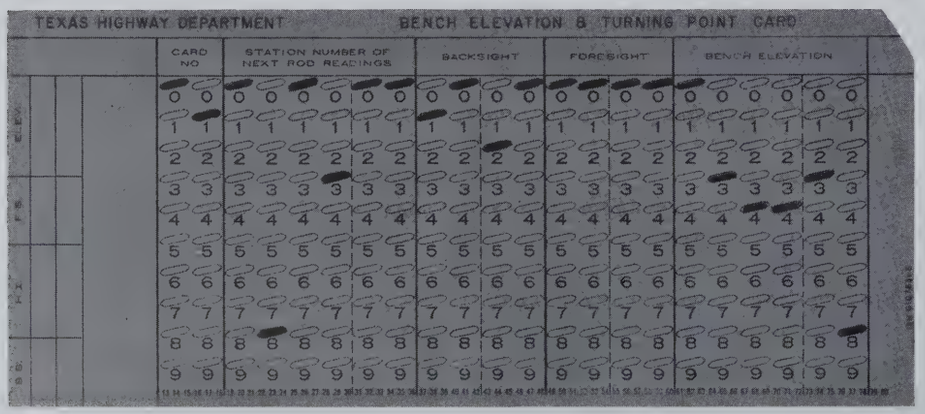


The surveyor places the Philadelphia rod on a known elevation (C) of 344.38 feet above sea level and sights through his instrument. He reads 10.20 on the rod, and finds the height of his instrument to be 354.58 (344.38 + 10.20). When the rod is placed on a typical cross-section point (A), the surveyor reads the number 6.0 on the rod. This reading can be recorded either on a mark-sense card or a printed form. Along with the rod reading, the distance from an arbitrary reference line is recorded (150 feet left for point (A) in example). The computer subtracts each reading from the instrument height and obtains the elevation of the ground. For point (A), 354.58 minus 6.0 gives a ground elevation of 348.6.

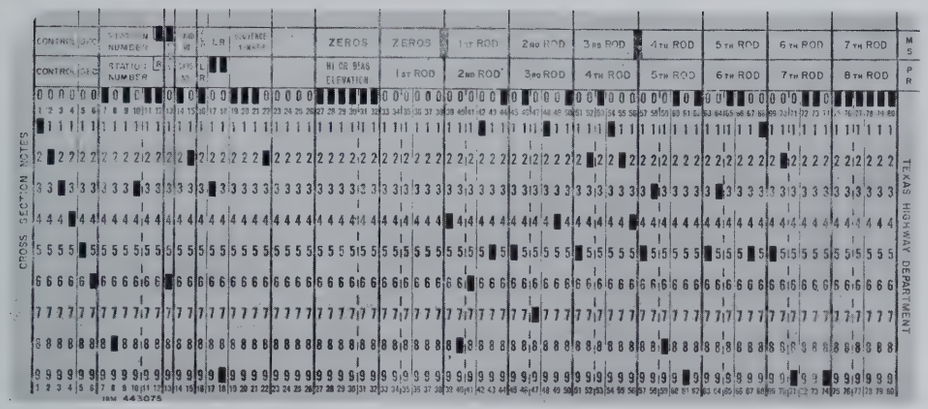
REFERRING TO POINT A
STATION 803



The mark-sense card, filled out in the field, contains data for point (A). The station number is 0803 + 00, card number 02, rod reading 6.0, and distance from the reference line is 150 feet to the left. Additional spaces on the card will be filled with information taken at other distances to the left, and later to the right, of the center line. A special electrographic pencil is used to record this data.



The bench-elevation and turning-point card contains the station number at which the elevation is to be first applied (0803 + 00) and the card number (01). Also listed are backsight (10.20), foresight (0), and elevation of a known point on the ground, (344.38).



At the Austin office, mark-sense cards are run through a machine which detects the pencil markings and transfers data to punched cards. The pencil marks pass under a set of brushes which complete circuits and punch holes in the card.

CONTROL	SEC.
1234	56

TEXAS HIGHWAY DEPARTMENT

LISTING OF MARK SENSING CARDS (CROSS SECTION DATA)

MO.	DAY	YEAR
10	21	58

STATION NUMBER	CARD NO.	LEFT OR RIGHT	BACK SIGHT	FORE SIGHT	ELEVATION	ROD	DIST.	ROD	DIST.	ROD	DIST.	ROD	DIST.	ROD	DIST.	ROD	DIST.	ROD	DIST.	ROD	DIST.
803+00	1		10.20		344.38																
+	2	L				6.0	150	3.9	140	2.6	124	.8	90	1.6	51	1.7	9				
+	3	R				2.0	6	3.6	30	5.3	55	8.3	79	10.5	100	9.4	124	7.6	140		
+	4	R				8.3	150														
+																					
804+00	1	R				8.4	150	7.6	136	7.6	104	9.4	70	10.5	36	10.0	10				
+	2	L				11.5	000	11.5	101	11.3	127	10.7	142	9.6	150						
+																					
805+00	1	L				13.4	150	15.6	135	16.0	97	13.9	52								
+	2	R				13.9	25	13.1	70	14.3	110	14.6	150								
+																					
+																					
+																					
+																					

Information, exactly as contained on the mark-sense cards, is listed on this form, which is returned to the field. This data does not contain actual elevations, only bench elevations, rod readings, and distances either to the right or left of the reference line.

CONTROL	SEC.
1234	56

TEXAS HIGHWAY DEPARTMENT

EARTHWORK ELEVATIONS

MO.	DAY	YEAR
10	17	58

ROW	STATION NUMBER	CARD NO.	ELEVATION	DISTANCE	L&R OR IDENT.	ELEVATION	DISTANCE	L&R OR IDENT.	ELEVATION	DISTANCE	L&R OR IDENT.	ELEVATION	DISTANCE	L&R OR IDENT.	ELEVATION	DISTANCE	L&R OR IDENT.	ELEVATION	DISTANCE	L&R OR IDENT.	ELEVATION	DISTANCE	L&R OR IDENT.
	803+00	1	348.6	150.0	L	350.7	140.0	L	352.0	124.0	L	353.8	90.0	L	353.0	51.0	L	352.9	9.0	L			
	+	2	352.6	6.0	R	351.0	30.0	R	349.3	55.0	R	346.3	79.0	R	344.1	100.0	R	345.2	124.0	R			
	+	3	347.0	140.0	R	346.3	150.0	R															
	+																						
	804+00	1	345.0	150.0	L	343.9	142.0	L	343.3	127.0	L	343.1	101.0	L	343.1	000.0	L	344.6	10.0	R			
	+	2	344.1	36.0	R	345.2	70.0	R	347.0	104.0	R	347.0	136.0	R	346.2	150.0	R						
	+																						
	805+00	1	341.2	150.0	L	339.0	135.0	L	338.6	97.0	L	340.7	52.0	L	340.7	25.0	R	341.5	70.0	R			
	+	2	340.3	110.0	R	340.0	150.0	R															
	+																						
	+																						
	+																						
	+																						

When the field requests it, rod readings and distances are put through the computer. Actual elevations above sea level are provided for all readings at all stations.

EARTHWORK

PROFILE DATA DISTANCES

1 4	5 6	7 12			
CONTROL	SEC.	STATION NUMBER	DISTRICT	COUNTY	NO.
W 1 2 3 4	5 6	1 8 0 3+0 0			

26 30	35 36
DISTANCE	LEFT
1 2 0 0	L 0 1
1 1 8 5	L 0 2
0 3 4 0	L 0 3
0 0 0 0	L 0 4
	L 0 5
	L 0 6

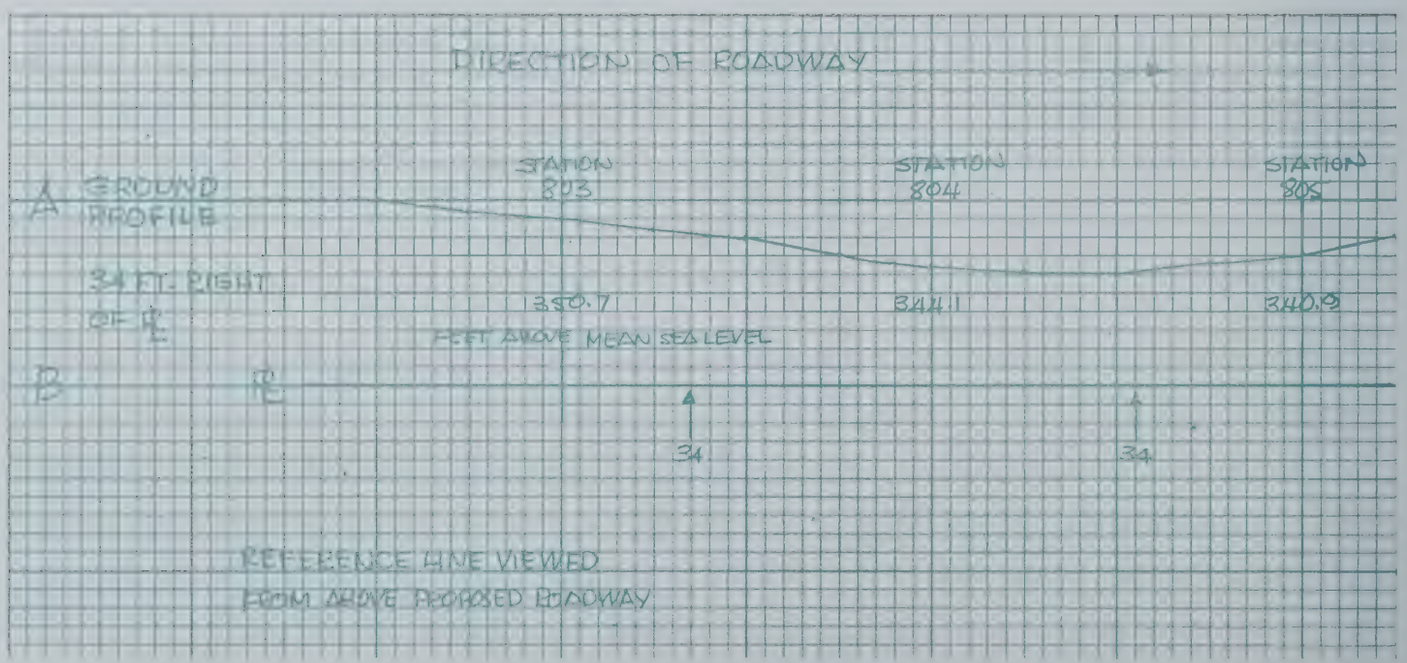
26 30	35 36
DISTANCE	RIGHT
0 3 4 0	R 5 1
1 1 8 5	R 5 2
1 2 0 0	R 5 3
	R 5 4
	R 5 5
	R 5 6

Next step is a profile of the roadway. On this form the field may request elevations of all points at a specified distance right or left of the center line. The resulting computation will allow a profile of all such points to be plotted.

1234 56 10 17 58

	120.0L	118.5L	34.0L	0	34.0R	118.5R
803 00	352.2	352.3	353.0	352.7	350.7	345.0
804 00	343.3	343.2	343.1	343.1	344.1	347.0
805 00	338.8	338.8	340.7	340.7	340.9	340.2

This form, with three stations listed, gives the elevations of points either right or left of the center line as requested by the field.



The field has requested elevations on all points 34 feet to the right of the center line. Computations will render this plotted profile.

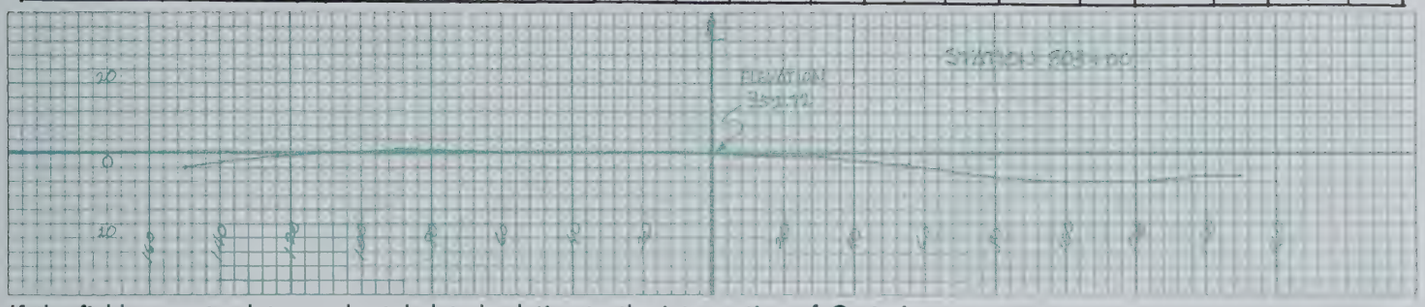
TEXAS HIGHWAY DEPARTMENT

CONTROL	SEC.
1234	56

EARTHWORK COORDINATES OF ROD READINGS

MO.	DAY	YEAR
10	15	58

STATION NUMBER	CARD NO.	CENTER LINE GROUND ELEVATION	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X
803 00	1	352 72	4 1-	150	2 0-	140	7-	124	1 1	90	3	51	2	9					1-	6
	2	352 72	1 7-	30	3 4-	55	6 4-	79	8 6-	100	7 5-	124	5 7-	140	6 4-	150				
804 00	1	343 10	1 9	150	8	142	2	127		101			1 5	10	1 0	36	2 1	70		
	2	343 10	3 9	104	3 9	136	3 1	150												
805 00	1	340 70	5	150	1 7-	135	2 1-	97		52				25	8	70	4-	110		
	2	340 70	7-	150																



If the field requests, data can be tabulated relative to the intersection of Cartesian coordinates at the reference line (0, 0). The original cross section will be reproduced numerically as it would appear on a graph with X and Y axes. Data is tabulated on this form and returned to the field.

CONTROL	SEC.
1 2 3 4	5 6

Texas Highway Dept.
EARTHWORK
ROADBED DESIGN TEMPLATE

DIS-TRICT	COUNTY No.

STATION	RULE	LEFT SHOULDER WIDTH	LEFT SHOULDER VERTICAL CROWN	LEFT TRENCH DEPTH	LEFT CROWN WIDTH	LEFT VERTICAL CROWN	RIGHT CROWN WIDTH	RIGHT VERTICAL CROWN	RIGHT TRENCH DEPTH	RIGHT SHOULDER WIDTH	RIGHT SHOULDER VERTICAL CROWN	TEMPLATE NUMBER
0803+00	1	000	000	067	250	025	350	070	075	000	000	01
		000	000	075	350	070	250	025	067	000	000	02
		000	000	100	170	034	080	016	000	090	036	03
		090	036	000	080	016	170	034	100	000	000	04
		000	000	100	170	034	080	016	100	140	056	05
0803+00	1	140	056	100	080	016	170	034	100	000	000	06

COL.	13	25	37	44	47	61	64	67	70
	0 0 0 0 0 0 0 3	0 0 0	0 0 0 0 0 0 0 0						

SOLID ORANGE

CONTROL	SEC.
1 2 3 4	5 6

Texas Highway Dept.
EARTHWORK
OUTSIDE DITCH DESIGN TEMPLATE

DIS-TRICT	COUNTY No.

STATION	RULE	Ditch Depth	Ditch Width	Distance Toe of Front Slope	L or R	Cut Slope	FILL SLOPE DATA HEIGHT A	Slope A	HEIGHT B	Slope B	HEIGHT C	Slope C	Back Slope No. 3	Distance Top of Back Slope No. 3	L or R	Height Back Slope No. 3	Back Slope No. 4	Template Number
0803+00	1	05	00	000	0	060	00	600	02	400	04	200	040	0000	0	000	0000	01
0803+00	1	00	00	000	0	000	00	000	00	000	00	000	000	0000	0	000	0000	02
							00											
							00											
							00											
							00											
							00											
							00											
							00											
							00											
							00											
							00											
							00											
							00											

COL.	13	20	35	54	56	64	67	71	74	77	80
	0 0 0 0 0 0 0 4	0 0 0	0 0 0 0 0 0 0 0								

SOLID GREEN

CONTROL	SEC.
1 2 3 4	5 6

Texas Highway Dept.
EARTHWORK
INSIDE DITCH DESIGN TEMPLATE

DIS-TRICT	COUNTY No.

STATION	RULE	Ditch Depth Off Main Roadbed	Ditch Depth Off Frontage Road	Distance to Toe of Slope off Main Roadbed	L or R	SLOPE	Maximum Frontage Road Slope	DITCH WIDTH	Template Number
0803+00	1	000	000	835	R	030	000	030	01
	1	000	000	835	L	030	000	030	02
0803+00	2	000	000	000	L	000	000	000	03

COL.	13	20	37	41	44	47	50
	0 0 0 0 0 0 0 7	0 0 0	0 0 0 0 0 0 0				

SOLID RED

In planning a roadway design with aid from the Computer Section, the designer can form templates for roadbeds, inside ditches, and outside ditches. These templates are combinations of various geometric shapes, expressed numerically. Twenty templates for each area—roadbeds, inside ditches, and outside ditches—can be stored in the computer at any one time and called for by number as needed. The design features of each station are computed using the templates of the roadbed and ditch shapes sought. Resulting figures will show numerically the design cross section.

Texas Highway Dept.
EARTHWORK
ENGINEERS COMPUTED HORIZONTAL CROWNS

CONTROL	SEC.	DIS-TRICT	COUNTY No.
1234	56		

STATION	Roadbed No.	LEFT Horizontal Crown	RIGHT Horizontal Crown
08+00	2	40	25
08+50	2	40	25
08+400	3	25	40
08+500	3	25	40

COL. 13 29 31 33 37 40 44 50
0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

SOLID YELLOW

Texas Highway Dept.
EARTHWORK
ENGINEERS COMPUTED VERTICAL CROWNS

CONTROL	SEC.	DIS-TRICT	COUNTY No.
1234	56		

STATION	Roadbed No.	LEFT VERTICAL CROWN	RIGHT VERTICAL CROWN
08+002	2	08	025
08+502	2	08	025
08+403	3	025	080
08+503	3	025	080

COL. 13 29 31 37 41 47 51 60
0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

SOLID YELLOW

Texas Highway Dept.
EARTHWORK
MACHINE COMPUTED DITCH ELEVATIONS

CONTROL	SEC.	DIS-TRICT	COUNTY No.
1234	56		

Beginning Station	Ditch Number	* Ditch	Beginning Ditch Elevation	Ending Station	Ending Ditch Number	Ending Ditch Elevation
08+00	2	0	3515	08+00	5	03535

COL. 13 29 31 34 40 44 51 54 60
0 0 0 0 0 0 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

SOLID YELLOW

* Ditch No. can be only L, 1, 2, 3, or R

Texas Highway Dept.
EARTHWORK
MAXIMUM SLOPE INTERCEPT DISTANCE

CONTROL	SEC.	DIS-TRICT	COUNTY No.
1234	56		

STATION	LEFT SLOPE INTERCEPT DISTANCE	L or R	RIGHT SLOPE INTERCEPT DISTANCE	L or R
08+00	145	L	145	R
08+500	100	L	100	R

If the outside distance of the original cross section is to be the maximum slope stake distance, put on this form some value of distance further out than any of the rod readings on the original cross sections.

SOLID BLUE

COL. 13 25 31 35
0 0 0 0 0 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

Several modifications of templates can be made at any time. These forms show the engineer's requests for modification in small areas, such as superelevation and straight-line ditches.

Texas Highway Dept.

EARTHWORK

DESIGN CROSS SECTION

CONTROL	SEC.
1	56

DIS-TRICT	COUNTY No.

STATION	ROAD-BED USED	ROADBED No. 1				ROADBED No. 2				ROADBED No 3				ROADBED No 4			
		CENTERLINE ELEVATION	DISTANCE ℄ From	L or R	Template No.	CENTERLINE ELEVATION	DISTANCE ℄ From	L or R	Template No.	CENTERLINE ELEVATION	DISTANCE ℄ From	L or R	Template No.	CENTERLINE ELEVATION	DISTANCE ℄ From	L or R	Template No.
08 03 00	F M M F	01 03 46.00	1 18.5	L	04	02 03 50.00	03 40	L	02	03 03 50.00	03 40	R	01	01 03 46.00	1 18.5	R	03 01
08 04 00	F M M F	02 03 47.00	1 20.0	L	06	03 03 51.00	03 40	L	02	03 03 51.00	03 40	R	01	03 03 47.00	1 20.0	R	05 02
08 05 00	M M	02 0	←			→ 03 03 52.50	03 40	L	02	03 03 52.50	03 40	R	01	0 ←			→ 02

calls for template

BLUE STRIPE

COL	13	14
	3	0

On this form, the engineer specifies the templates he wants at each station, and positions them relative to the original cross section.

CONTROL	SEC.
1234	56

TEXAS HIGHWAY DEPARTMENT

EARTHWORK OUTSIDE DITCH DESIGN

MO.	DAY	YEAR
10	21	58

STATION NO.	LEFT DITCH DESIGN								RIGHT DITCH DESIGN							
	ADJ.	POINT OF INTERSECTION	INTERSECTING SLOPE RATIO	INTERSECTING SLOPE NO	DISTANCE TOE BACK SLOPE	ELEVATION	DITCH DEPTH	DISTANCE TOE FRONT SLOPE	FRONT SLOPE RATIO	ADJ.	POINT OF INTERSECTION	INTERSECTING SLOPE RATIO	INTERSECTING SLOPE NO	DISTANCE TOE BACK SLOPE	ELEVATION	DITCH DEPTH	DISTANCE TOE FRONT SLOPE	FRONT SLOPE RATIO
803 00	8	145.0L	1.4-	3		345.0	.5	138.5L	6.0	8	145.0R	3.9-	3		345.0	.5	138.5R	6.0
804 00	8	145.0L	1.8	1				145.0L	1.8	8	145.0R	1.8-	1				145.0R	1.8-
805 00	8	100.0L	1.8	1				100.0L	1.8	8	100.0R	2.1	1				100.0R	2.1

CONTROL	SEC.
1234	56

TEXAS HIGHWAY DEPARTMENT
EARTHWORK INSIDE DITCH DESIGN

MO.	DAY	YEAR
10	21	58

STATION	LEFT DITCH DESIGN								CENTER DITCH DESIGN							RIGHT DITCH DESIGN							
	ADJ.	LEFT SLOPE RATIO	DISTANCE TOE OF LEFT SLOPE L or R	DEPTH	ELEVATION	DEPTH	DISTANCE TOE OF RIGHT SLOPE L or R	RIGHT SLOPE RATIO	ADJ.	LEFT SLOPE RATIO	DISTANCE TOE OF LEFT SLOPE L or R	DEPTH	ELEVATION	DEPTH	DISTANCE TOE OF RIGHT SLOPE L or R	RIGHT SLOPE RATIO	ADJ.	LEFT SLOPE RATIO	DISTANCE TOE OF LEFT SLOPE L or R	DEPTH	ELEVATION	DEPTH	DISTANCE TOE OF RIGHT SLOPE L or R	RIGHT SLOPE RATIO
803 00		3.0	86 L	4.7	342.7	7.4	83 L	1.9		2.96-	R	3-	351.2	3-	R	2.96-		1.9	84 R	7.4	342.7	4.7	87 R	3.0
804 00	9							4.8		1.93-	R	4-	352.4	4-	R	1.93-	9	4.8						
805 00									6	3.8-	R	1-	353.5	1-	R	3.8-								

CONTROL	SEC.
1234	56

TEXAS HIGHWAY DEPARTMENT
EARTHWORK ROADBED DESIGN

MO.	DAY	YEAR
10	21	58

STATION NO.	ROAD NO.	LEFT SHOULDER WIDTH	LEFT SHOULDER VERTICAL CROWN	LEFT TRENCH DEPTH	LEFT CROWN WIDTH	LEFT VERTICAL CROWN	RIGHT CROWN WIDTH	RIGHT VERTICAL CROWN	RIGHT TRENCH DEPTH	RIGHT SHOULDER WIDTH	RIGHT SHOULDER VERTICAL CROWN	ROAD NO.	LEFT SHOULDER WIDTH	LEFT SHOULDER VERTICAL CROWN	LEFT TRENCH DEPTH	LEFT CROWN WIDTH	LEFT VERTICAL CROWN	RIGHT CROWN WIDTH	RIGHT VERTICAL CROWN	RIGHT TRENCH DEPTH	RIGHT SHOULDER WIDTH	RIGHT SHOULDER VERTICAL CROWN
803 00	1	9.0	.36		8.0	.16	17.0	.34-	1.00						.75	35.0	.70	25.0	.25-	.67		
804 00	1	14.0	.56-	1.00	8.0	.16	17.0	.34-	1.00						.75	40.0	.80	25.0	.25-	.67		
805 00															.75	40.0	.80	25.0	.25-	.67		

These sheets show listings of components of the design cross section computed from field request forms. This information goes back to the field.

CONTROL	SEC
1234	56

TEXAS HIGHWAY DEPARTMENT
EARTHWORK ELEVATIONS

MO.	DAY	YEAR
10	21	58

STATION NUMBER		ELEVATION	DISTANCE	L&R OR IDENT	ELEVATION	DISTANCE	L&R OR IDENT	ELEVATION	DISTANCE	L&R OR IDENT	ELEVATION	DISTANCE	L&R OR IDENT	ELEVATION	DISTANCE	L&R OR IDENT	ELEVATION	DISTANCE	L&R OR IDENT
803					349.7	145.0	L2	345.0	138.5	L1	345.5		11	345.8	126.5	13	346.0	118.5	14
					346.3	101.5	L5	347.3	100.0	L6			18			19			22
					349.3								17			26			29
													28			33			36
											361.7	100.0	42	346.3	101.5	43	346.0	118.5	44
					345.8								R1	346.7	145.0	R2			
804+00	1				344.5	145.0	L1				344.3	122.0	12	343.8	128.0	13	344.0	120.0	14
+	2							347.3	102.0	16	351.0	74.0	22	350.2	74.0	23	351.0	34.0	24
+	3				351.3	9.0	25			28		000.0	28	351.9	8.3	32	351.3	9.0	33
+	4				351.0				74.0		351.0		28	345.3	102.0	42	344.3	103.0	43
+	5				344.0							129.0	48	345.4	143.0	47	346.5	145.0	R1
+																			
805+00	1				338.6				74.0	22	351.7	74.0	28	352.5	34.0	24	352.8	9.0	25
+	2				353.4	8.3	30			29	353.4	8.3	32	352.8	9.0	33	352.5	34.0	34
+	3				351.7	74.0	33		74.0	36	340.6	100.0	R1						
+																			
+																			
+																			
+																			

The field also receives a listing of design earthwork elevations. Elevations are computed from templates of roadbed and ditch shapes. After this data has been returned to the field, examined, and either changed in some locations or left in its original form, earthwork elevations for the corrected design cross section are computed, listed, and sent back to the field for final approval.

DESIGN EARTHWORK COMPUTATIONS

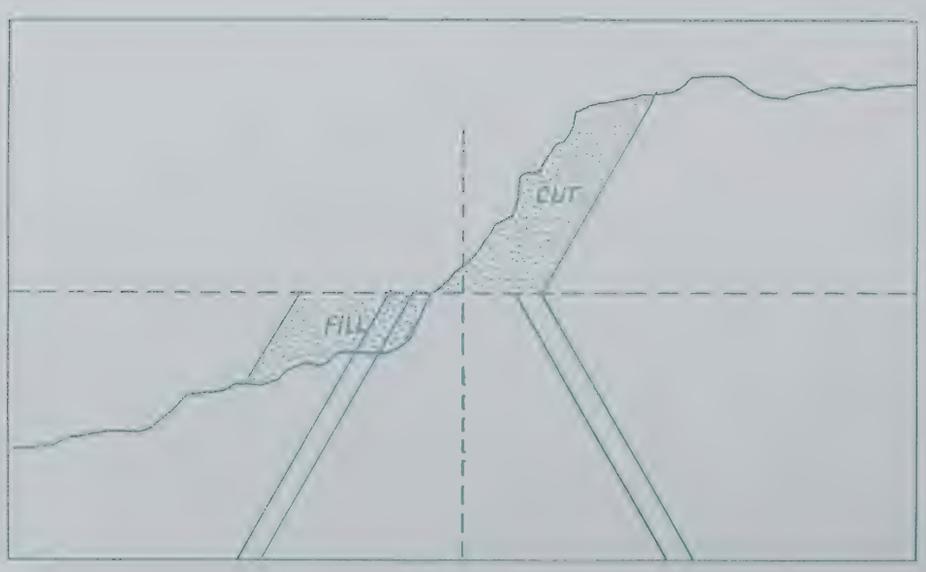
DISTRICT
COUNTY

10 21 58

CONTROL
HWY. NO.

1234-56

CONTROL	STA.	ELEVATION	CUT VOLUME	FILL VOLUME	ADJUSTED FILL VOLUME	ACCUMULATED CUT	ACCUMULATED ADJUSTED FILL	ACCUMULATED VOLUME (HAUL DIAGRAM ORDINATES)
	803 00	351.20						
	804 00	352.35	1724	2557	3196	1724	3196	1472-
	805 00	353.50	202	6218	7773	1926	10969	9043-



If the field approves, final earthwork-quantity computations are made. Basically, the design cross sections are compared with original cross sections. Cut and fill areas are computed, and areas of adjacent stations averaged and multiplied by the distance between stations. Resulting tabulations indicate the volume of earth to be removed or filled.

LATEST OVERHEAD SIGN SUPPORTS

The Interstate Highway Program has accelerated all phases of highway design, maintenance, and operation.

In anticipation of the likelihood that larger guide signs would be required for the Interstate System, the Division of Maintenance Operations initiated design studies seeking attractive though economical designs for overhead structures. As signs become larger, of course, the wind loading increases with the increased area of sign surface—thus necessitating stronger horizontal members. Since the overhead clearance above roadways cannot be reduced below desirable minimums, deeper signs require stronger supporting structures and foundations.

Structures for overhead signs fall into two basic types: the tee, which is used between divergent roadways; and the bridge, which spans one or more roadways.

District 2 has recently erected some of the Department's latest designs on S.H. 550 in downtown Fort Worth. The bridge and supports are made of pipe. The horizontal ten-and-one-half-inch 6061-T6 aluminum pipe members are internally stressed to eliminate sagging of horizontal pipe members.

Aluminum was used for the span members of the pipe bridge for three reasons.

(1) Aluminum is lighter.

(2) Aluminum has a Young's Modulus of Elasticity which is about one-third that of steel, therefore it can deflect three times as far as a steel member with the same maximum extreme fiber stress.

(3) Aluminum is more resistant to corrosion than steel, therefore painting over the roadway should be virtually eliminated.

The bridge erected in Fort Worth has an 80-foot clear span. The tee mounts placed on S.H. 550 have various combinations of spans, one a 36-foot by 20-foot, and quite a few 30-foot by 30-foot tees. One, pictured, is a 36-foot by 36-foot.

The signs pictured in this article were designed prior to the release of "The American Association of State Highway Officials Manual for Signing and Pavement Marking of the National System of Interstate and Defense Highways" and they will eventually be replaced with signs which conform to Interstate standards.

W. R. Welty, Senior Traffic Engineer
Maintenance Operations Division

The sign bridge, as it appears from the roadside.

This 80-foot sign bridge was erected in downtown Fort Worth on S. H. 550.

Base for the tee-mount signs is mounted between divergent highways.

There are 36 feet of signs on each side of this tee mount on S. H. 550 in Fort Worth.

Use of Heated Aggregates for Winter Surface Treatments

Wade O. Crawford, District Construction Engineer
District 8

Ideal conditions for securing good results in asphalt surface treatments are hot weather, a warm surface upon which the asphalt surface is applied, and lots of good hot curing weather.

During the asphalt season some or all of these conditions are met, giving us from satisfactory to good asphalt surfaces, depending upon the time of season. However, this leaves six or seven months of the year when normally none of the ideal conditions can be met.

During the past several years, with the increase of highway construction, it is becoming harder and harder to schedule jobs in such a manner that they will be completed during the asphalt season. Therefore, it is more and more important that some satisfactory methods be developed which will enable us to place asphalt surfaces the year around.

A year ago this winter, we had a hot-mix asphaltic concrete project with paved shoulders and frontage roads complete except the single asphalt surfaces on the shoulders and frontage roads. The contractor approached us with the idea of heating the aggregates and placing these surfaces during the winter months. We agreed to this. We secured a Memorandum Agreement in which the contractor agreed to heat the aggregates at the contract price. This method gave a satisfactory surface and allowed us to open the projects months early.

Since then we have used the method satisfactorily on three similar projects. We are in the process of using it on another job now under construction.

This process is almost in reverse of normal asphalt work. Normally, the aggregate is applied to the hot liquid asphalt, but in this process hot aggregates are applied to cold asphalt. The aggregates reheat the asphalt, allowing the aggregate to penetrate the film of asphalt.

The only projects on which we have used the heated aggregates were located where a hot-mix plant was available. I am sure there are other ways developed or being developed to heat the aggregate.

The aggregates are stockpiled at the site of the hot-mix plant, run through the dryer, and heated to a temperature of 250 degrees Fahrenheit. This heating also serves two other purposes. Two of the things that retard the adherence of the asphalt to the aggregates are moisture and excessive dust in the aggregates. During any stockpiled period the aggre-

*Speech presented at the Thirty-second Short Course.

gates are apt to become moisture laden. During winter months we can expect very little drying of the aggregates. Heating will assure us of a dry aggregate when it is applied. To some small extent the dust condition is improving as a per cent of dust is collected in the dust collector or blown out the stack of the plant.

Prior to any application of asphalt it should be assured that enough trucks are available to cover the asphalt as soon as possible. The asphalt will chill almost immediately and any heat remaining in the asphalt will be of benefit.

In applying, the same type of asphalt specified on the plans is used and applied at about 335 degrees. In our case we use OA 135 asphalt at a rate of .35 gallons to .40 gallons per square yard for a single and aggregate of Grade 5 Type A for shoulders.

When everything is in readiness the asphalt is shot, and aggregates applied immediately. Temperature of the aggregate is checked in the truck to assure that the heat has been maintained. The aggregates will maintain their heat in the trucks within a very few degrees, however, once they are applied with the spreader individually they cool almost immediately. Extreme care must be taken in applying the cover aggregate. Each rock must fall into as near it final position as possible while enough heat is still retained to insure its penetration into the film of asphalt. Once the cover aggregate is applied, there is no such thing as shifting the aggregate to cover bare spots or thin places as is usually done by blading or drag brooming. Necessarily, this causes us to apply more aggregate than normal to assure a complete cover without shifting the aggregates.

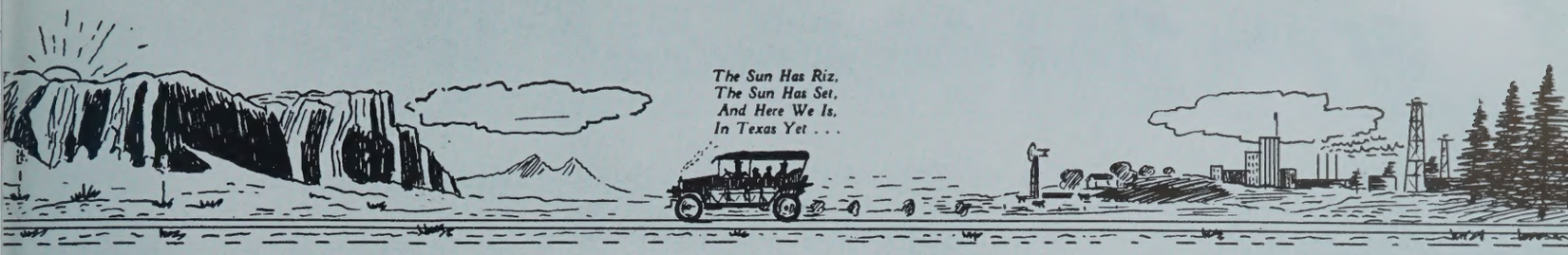
Due to its ability to give a much more uniform application of cover aggregate, the self-propelled aggregate spreader shows a definite saving in aggregate.

Immediately after application of the cover aggregate, flat-wheel rollers and pneumatic rollers are started. It is essential that the rolling be secured while aggregates and asphalt have the maximum heat possible. Application of the aggregate should never get far ahead of the rolling. It is obvious that this method of applying surface treatment is more expensive to both the contractor and the Highway Department. However, the contractors are usually willing to absorb the additional cost to complete the project and receive their retainage fee. In some instances, this represents a large sum. As far as the Highway Department is concerned the only additional cost is the excess amount of aggregate required. We must always keep in mind that the product we have to sell is highway facilities, and our product is not complete until it is under traffic.

To illustrate this we completed a project in early December in which the contractors retainage was approximately $150,000. The traveling public got the use of a completed highway facility at least five months earlier than if heated aggregates had not been used.

As I have stated previously, the only times we have used the heated aggregates were where hot-mix plants were available and the contractor agreed to place the cover aggregate at contract price. Consequently, I cannot quote the price of aggregates where heating would be specified. However, a reliable contractor has stated he thought he could develop a portable unit to heat aggregate for a cost of less than 25 cents more per cubic yard.

My experience in heated aggregate has been very limited, but has proved that we can secure satisfactory pavements in the winter. The field is wide open for research in heated aggregate for both winter and summer asphalt surfaces.



OVER THE HIGHWAYS

Comments . . . from the Traveling Public

A few days ago, I was on my way to Corpus Christi from San Antonio at about 7 p.m. when I encountered difficulty with my car in the vicinity of Pleasanton. Your Mr. J. L. Copenhaver, of your San Antonio office, happened along and offered his assistance. He drove several miles to a filling station in an effort to send someone to me, and when he was unable to find someone available, he returned and was instrumental in getting me to a garage.

I understand that it is the policy of the Highway Department to assist in such emergencies, but I feel that Mr. Copenhaver went beyond the normal call of duty it was late in the evening and past his assigned working hours. He flatly refused payment for his services and insisted that it was a complete pleasure to be of assistance to me.

I would like to take this opportunity to express my appreciation to the Highway Department and to commend Mr. Copenhaver for his action. I would appreciate very much your passing on to Mr. Copenhaver and the San Antonio office my appreciation for their services.

Omar Harvey
San Antonio

On September 11 we ate at the roadside park near Deweyville, Highway 235, and left a small black case in which were a Bible I had used for many years, a leather-bound New Testament which Arthur A. Everts, the jeweler of Dallas, Texas, had given me before he died, and outlines I had made on about twenty books of the Bible. We were carrying a little grandson back to his parents in Baton Rouge and used the overnight case for him to sit on at the table. Somehow we failed to see the case when we left.

We came back the next afternoon but the case was gone. We asked about it at the eating places and at several gas stations but to no avail. The things in the case would be of little value to anyone else, but they mean a lot to me and I would certainly appreciate any help you can give in helping me find them. Of course I stand ready to do what I can. Someone suggested it might be at the county barn in Orange. I met one of the men who said he would see and call me. I would gladly pay the charges.

Thanking you for your attention to my request, I beg to remain,

Earl Hanson Fife, Minister
Memorial Christian Church
1001 Mae Drive
Houston, Texas

My family and I used the facilities of the roadside park on Highway 21, seventeen miles east of Bryan, Texas, this last Sunday.

I would like to commend your Department for its excellent job there and say that a park of this kind adds to the beauty of Texas and eases the mental anguish of high taxes.

G. L. Waters
College Station, Texas

Terribly sorry to hear you aren't the largest state. I have sympathy for you, so please send me some free information, pamphlets, maps, and post cards about your state. Thank you.

Jane Mueller
Buffalo, New York

The best highways of the states we traveled in (Texas, New Mexico, Arizona, California, Oregon, Washington, Montana, and Utah) were those of Texas. They are well-surfaced and well-marked. Nevada and Washington run a close second. California's highways are at least five years behind the current traffic load. Arizona's and New Mexico's are poorly surfaced and poorly marked. Canada's, or at least those in the part of Canada we drove through, are primitive in spots. They are about in the same condition as highways in Mexico were ten years ago.

Robert N. Pinkerton, President
Radio KIWW, Inc.
San Antonio, Texas

To and From Our Readers

I have read with a great deal of pride and gratification the November issue of TEXAS HIGHWAYS wherein a salute was given to the maintenance employees of the Texas Highway Department. This issue of our Department magazine was especially timely and significant since it followed closely the first Maintenance Operations Conference held in Austin on October 28, 29, and 30, at which the Highway Commission commended our maintenance employees for the important part they play and the fine work they are doing.

We in the Maintenance Operations Division commend you and your organization for the production of this interesting, timely, and appropriate issue of TEXAS HIGHWAYS. . . .

J. A. Waller
Chief Engineer of
Maintenance Operations

TEXAS HIGHWAYS was also commended by another group recently. In September, your magazine received the top award given by the Mid Continent Conference of Industrial Editors. There were 285 entries in the contest, representing twelve states. This First Award was given in recognition of exceptional accomplishment of purpose, excellence of editorial content, and effectiveness of design. A third place award went to TEXAS HIGHWAYS for an article, "History Along Our Highways," which appeared in the February, 1958, issue. This award was received in recognition of outstanding performance in writing the article judged to be most effective for the readers of the publication.

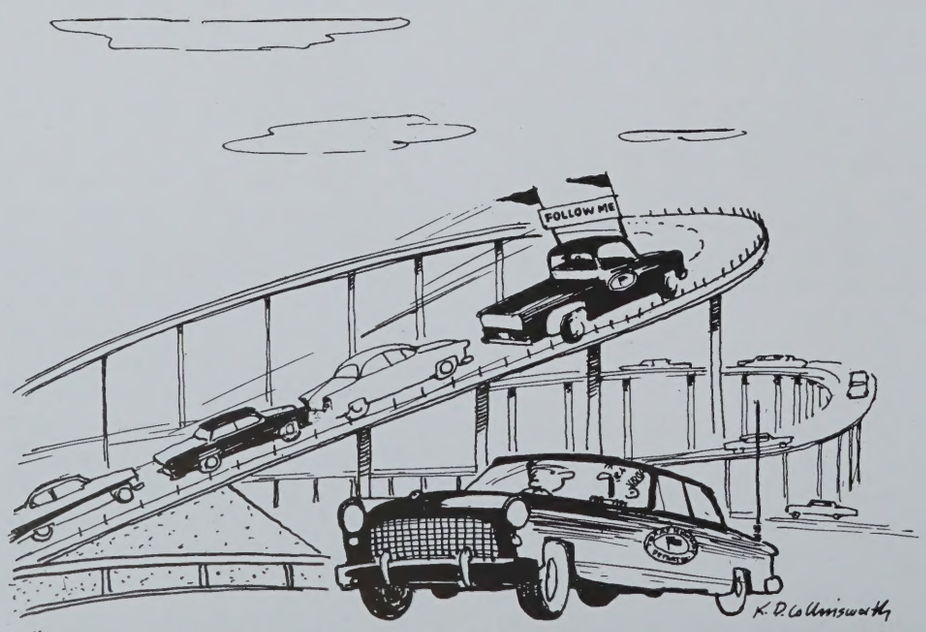
It is to the contributors in the field that the credit is due for TEXAS HIGHWAYS' award.

About the Cover . . .

'Tis the night before Christmas, and all along the highway it is quiet. A maintenance crew secures equipment as the evening star shines in the heavens. Just as the wise men some 2,000 years ago followed signs safely to their destination—so the wise travelers of today safely follow signs placed by our maintenance crews.

Picture for the December cover of TEXAS HIGHWAYS was made by staff photographer Douglas Fairchild, with the help of District 14 maintenance personnel. Harry Hogan, Skilled Laborer, nails a Merry Christmas sign to the barricade as Morris Alexander, Skilled Laborer, places a wreath on the maintainer. Clyde M. Tucker, Construction Superintendent, lights the last of the flares.

TEXAS HIGHWAYS takes this opportunity to wish each of you a happy and joyous Christmas season; and we hope that you will find enjoyment with each new issue of the magazine during the coming year.



"We just never could figure out a signing plan... so we *had* to think of something!"

TEXAS HIGHWAY COMMISSION

MARSHALL FORMBY	Chairman
HERBERT C. PETRY JR.	Member
CHARLES F. HAWN	Member
D. C. GREER	State Highway Engineer

Texas Highways

TEXAS HIGHWAYS, official journal of the Texas Highway Department, is published in the interest of highway development in Texas and for departmental education in the improvement of construction, maintenance, and operation.

All material and manuscripts should be directed to the Editorial Office, Division of Information and Statistics, Texas Highway Department, Austin 14, Texas.

HIGHWAY SIDELIGHTS

Gordon K. Shearer
Historian, Texas State Parks Board

Amazing bird colonies like this flock of young white pelicans photographed at Laguna Madre by the National Park Service have interested the federal government in a study of Padre Island for a new national park.

Padre Island parallels the Texas mainland for 98 miles, separated only by narrow Laguna Madre. It contains the longest stretch of undeveloped seashore remaining in the United States. Padre Island is easily reached at the north end from U. S. 77 at Corpus Christi by causeway. At the south end there is a causeway from the terminus of Texas Highway 100 at Port Isabel.

State parks are designated facing Laguna Madre at Port Mansfield and at Port Isabel. Nueces county and Cameron county maintain county parks on the island. Establishment of a national park would be an added tourist attraction on the Gulf Coast route to Mexico.